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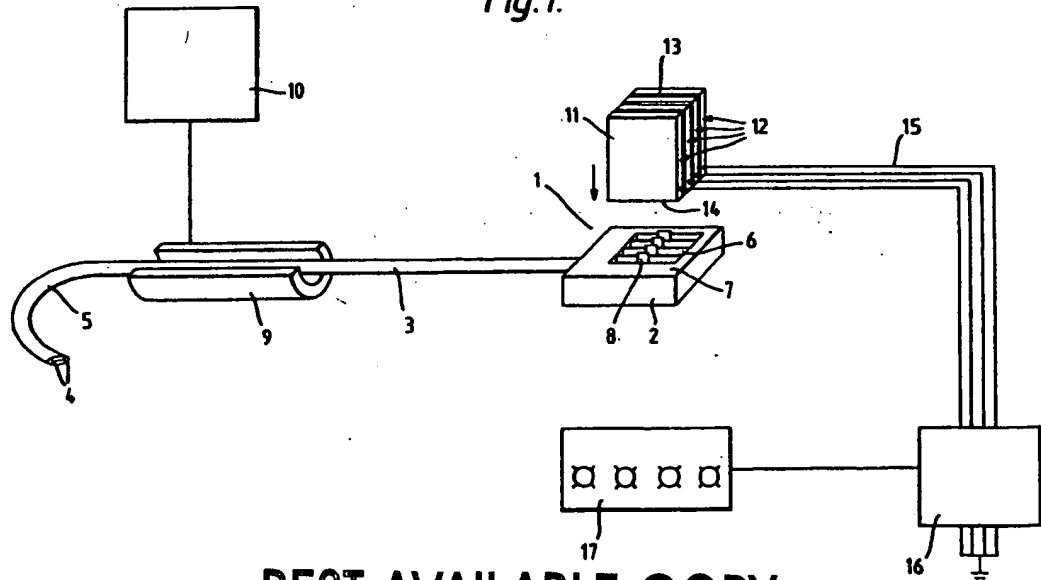
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(54) **Terminating electrical connectors**

(57) Apparatus for terminating a connector (2) on to an electric cable (3) includes a press tool (11) for engaging the connector and inserting one or more contact elements (8) to make an electrical connection with a respective conductor of the cable (3). A capacitive coupling plate (9), driven by an oscillator (10), produces a voltage signal on the one or more conductors of the cable. A detector (16) monitors the change in voltage of each of the contact elements (8) as they are inserted, the press tool (11) providing an electrical connection between the detector (16) and the contact elements (8). A signal is given should the change in voltage of any of the contacts fail to exceed a threshold value, indicating (17) that an inadequate electrical connection has been made.

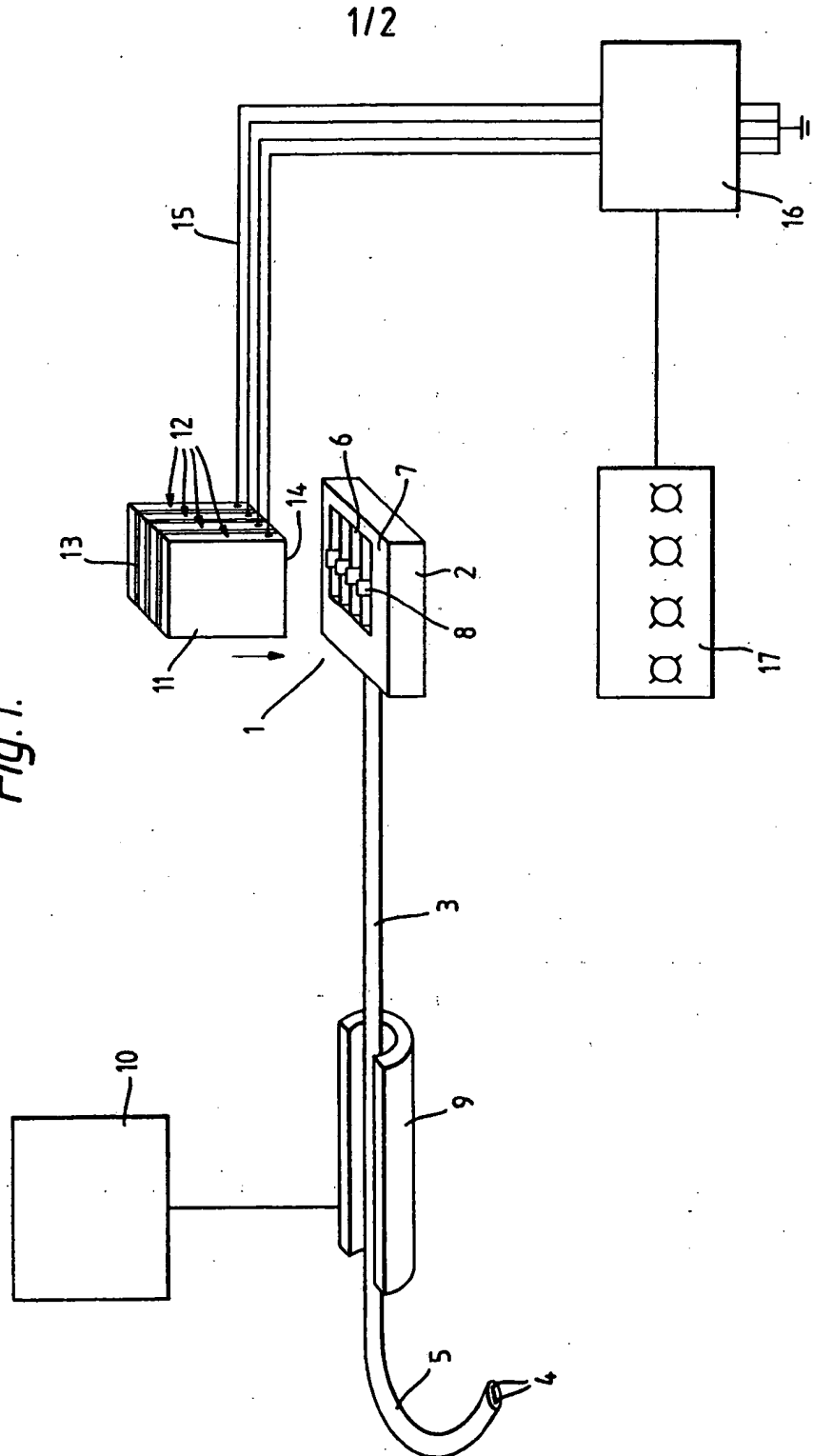
Fig.1.



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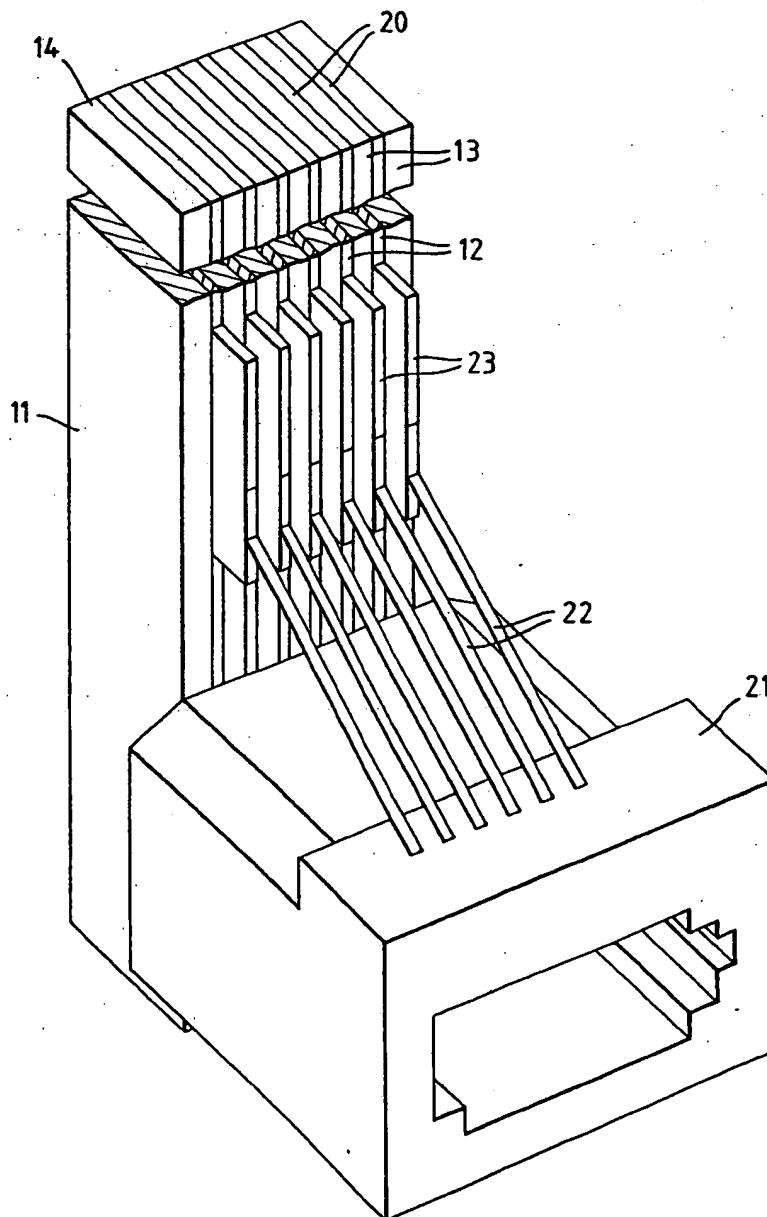
Fig. 1.



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Fig. 2.



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SPECIFICATION

Terminating electrical connectors

5 This invention relates to the terminating of a connector on to an electric cable and is particularly, though not exclusively, directed to the termination of pluggable telephone connectors.

Inadequate electrical connection in terminated connectors is a common cause of complaint. In order to maintain quality control, large batches of terminated connectors are taken out of the normal production process line for testing. This normally involves placing electrical probes on the contacts of the connector and on the conductors of the cable, and measuring the resistance therebetween. Such testing is most time consuming and in some cases it is necessary to test 100% of all terminated connectors manufactured.

10 It is an object of the present invention to provide a method and apparatus for terminating a connector on to an electric cable wherein a test is made, during termination of the connector, of the standard of electrical connection achieved.

Accordingly there is provided apparatus for terminating a connector on to an electric cable comprising a press tool adapted to engage the connector such that one or more contact elements are inserted therein to make an electrical connection with a respective conductor of the electric cable; means for producing a voltage signal on the one or more conductors of the electric cable; and detection means electrically connected to the one or more contact elements as they are inserted in the connector and adapted to monitor the change in voltage of each of the contact elements as they are inserted therein, the arrangement being such that the press tool provides an electrical connection between the detection means and the one or more contact elements.

As the one or more contact elements are inserted into the connector and make an electrical connection with a conductor provided with a voltage signal, the voltage of the contact elements will change accordingly, provided a proper electrical connection has been achieved. Conveniently the detection means is adapted to provide an indication should the change in voltage of any of the one or more contact elements be less than a predetermined threshold value. The detection means is conveniently adapted to activate a visual and/or audible alarm should the change in voltage be less than the predetermined threshold value. This will alert an operator that an inadequate electrical connection has been made. Additionally or alternatively the detection means is adapted to initiate a rejection procedure to divert a faulty connector from the usual exit path.

Preferably the press tool has an electrically conductive portion associated with each of the

one or more contact elements, each of the conductive portions being in electrical contact with its respective contact element when the press tool engages the connector, and the detection means is electrically connected to the one or more conductive portions of the press tool. The press tool is preferably provided with a plurality of conductive portions separated one from another by regions of electrically insulating material. Conveniently the press tool is of a laminar construction with a plurality of conductive portions separated one from another by layers of electrically insulating material.

80 Contact elements for use in terminating the connector are preferably of the insulating piercing (IPC) or insulation displacement (IDC) type. As the press tool engages the connector the one or more contact elements are inserted therein, piercing the insulating sheath of the conductors to make an electrical connection therewith.

Preferably the means for providing a voltage signal on the one or more conductors of the cable provides an AC voltage thereto. The means for providing a voltage signal conveniently comprises an oscillator and a capacitive coupling plate. The capacitive coupling plate is conveniently in the form of a substantially U-shaped trough in which the cable is received. The use of a capacitive coupling plate avoids the need for the free end of the cable to be physically connected to an electrical testing device. Indeed the free end of the cable may be left electrically floating, with the AC voltage signal being capacitively coupled on to the one or more conductors through the insulating covering of the cable. Alternatively the means for providing a voltage signal comprises an induction coil.

The invention further resides in a method of terminating a connector on to an electrical cable incorporating apparatus as above described. In particular a method of terminating a connector on to an electric cable incorporating one or more conductors includes the steps of providing a voltage signal on the one or more conductors of the electric cable; inserting into the connector one or more contact elements to make an electrical connection with a respective conductor of the electric cable; and monitoring the change in voltage on each of the one or more contact elements as they are inserted therein.

120 According to a still further aspect of the invention there is provided a press tool for use with the above described apparatus, the tool including at least one face adapted to engage a connector such that one or more contact elements are inserted therein; the face being provided with a plurality of electrically conductive portions separated one from another by regions of electrically insulating material. Preferably each conductive portion is provided with terminal means adapted to ef-

fect an electrical connection between the conductive portion and voltage monitoring apparatus. Conveniently the press tool has a socket attached thereto, terminals of the socket being in electrical connection with the respective conductive portions. Conveniently the socket is in the form of a pluggable telephone connector socket. The tool is preferably of laminar construction with a plurality of conductive portions separated one from another by layers of electrically insulating material.

The invention will now be further described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of apparatus according to the invention; and

Figure 2 is an elevational view of a press tool in accordance with a further aspect of the invention.

Referring to Fig. 1, the apparatus comprises a terminating station, shown generally at 1, at which station is presented a connector 2 and an electrical cable 3, the cable incorporating four conductors 4 within an outer sheath 5. Partially inserted into apertures 6 in the upper face 7 of the connector 2 are insulating piercing contact elements 8.

Downstream of the terminating station 1 is a capacitive coupling plate 9 in the form of a U-shaped trough, the plate 9 being supplied by a high frequency voltage oscillator 10. The plate is shaped such that the electric cable 3 may be received in the trough thereof.

At the terminating station is a press tool 11, the tool being shown only schematically in Fig. 1. The tool is essentially laminar in construction and comprises four conductive segments 12 with layers 13 of insulating material therebetween. The segments 12 extend longitudinally along the axis of movement of the press tool 11, such that they form conductive portions on the lower face 14 of the tool. Wires 15 connect each conductive segment 12 to a detector 16 which has an associated alarm unit 17.

The coupling plate 9 induces a high frequency voltage signal on to each of the conductors 4 of the electric cable. When the tool 11 moves down to terminate the connector 2, its lower face 14 engages the contact elements 8 such that one of the conductive segments 12 is in electrical contact with each of the respective contact elements 8.

As the press tool 11 travels further downwards it causes the contact elements 8 to pierce the insulation covering the conductors 4 and make electrical connections therewith. At this point the voltage of the contact elements 8 will change due to the AC voltage signal on the conductors as supplied by the oscillator 10 and coupling plate 9. This change in voltage will be detected by the detector 16 via wires 15 and the conductive segments 12 of the tool 11. Should the tool fail to produce a proper electrical connection between any of

the contact elements 8 and its respective conductor 4, the voltage change detected by the detector 16 will be considerably reduced, or even absent. In this case the detector will actuate the alarm unit 17, alerting an operator to the defective termination.

Fig. 2 shows, in more detail, a press tool for terminating connectors in the above described manner. The tool of Fig. 2 has six conductive segments 12, interspersed with layers 13 of insulating material. The face 14 for contacting the connector 2 therefore has six conductive portions as shown at 20. Attached to the side of the tool 11 is terminal means in the form of a PTC socket 21. Extending from the socket 21 are six electrical contacts 22 each of which are secured to a conductive segment 12 by means of a tab 23.

The detector 16 of Fig. 1 can be plugged into the press tool 11 by a PTC connector on the end of wires 15. The detector is thus in direct electrical communication with each of the conductive portions 20 and hence with the insulation piercing contact elements 8.

CLAIMS

1. Apparatus for terminating a connector on to an electric cable comprising a press tool adapted to engage the connector such that one or more contact elements are inserted therein to make an electrical connection with a respective conductor of the electrical cable; means for providing a voltage signal on the one or more conductors of the electric cable; and detection means electrically connected to the one or more contact elements as they are inserted in the connector and adapted to monitor the change in voltage of each of the contact elements as they are inserted therein, the arrangement being such that the press tool provides the electrical connection between the detection means and the one or more contact element.

2. Apparatus according to Claim 1 wherein the detection means is adapted to provide an indication should the change in voltage of any of the one or more contact elements be less than a predetermined threshold value.

3. Apparatus according to Claim 1 or Claim 2 wherein the press tool has an electrically conductive portion associated with each of the one or more contact elements, each of the conductive portions being in electrical contact with its respective contact element when the press tool engages the connector, and the detection means is electrically connected to the one or more conductive portions of the press tool.

4. Apparatus according to Claim 3 wherein the press tool is provided with a plurality of conductive portions separated one from another by regions of electrically insulating material.

5. Apparatus according to Claim 4 wherein

the press tool is of a laminar construction with a plurality of conductive portions separated one from another by layers of electrically insulating material.

- 5 6. Apparatus according to any of Claims 1 to 5 wherein the means for providing a voltage signal on the one or more conductors of the cable provides an AC voltage thereto.

- 10 7. Apparatus according to Claim 6 wherein the means for providing a voltage signal on the one or more conductors of the cable comprises an oscillator and a capacitive coupling plate.

- 15 8. Apparatus according to Claim 7 wherein the capacitive coupling plate is in the form of a substantially U-shaped trough, in which the cable is received.

- 20 9. Apparatus according to Claim 6 wherein the means for providing a voltage signal on the one or more conductors of the cable comprises an induction coil.

- 25 10. Apparatus according to any of claims 2 to 9 wherein the detection means is adapted to activate a visual and/or audible alarm should the change in voltage be less than the predetermined threshold value.

11. Apparatus substantially as hereinbefore described with reference to the accompanying drawings.

- 30 12. A method of terminating a connector on to an electric cable incorporating apparatus according to any of Claims 1 to 11.

- 35 13. A method of terminating a connector on to an electric cable incorporating one or more conductors, the method including the steps of providing a voltage signal on the one or more conductors of the electric cable; inserting into the connector one or more contact elements to make an electrical connection with a respective conductor of the electric cable; and monitoring the change in voltage of each of the one or more contact elements as they are inserted therein.

- 45 14. A method according to Claim 13 wherein the voltage signal provided on the one or more conductors of the electric cable is an AC voltage signal.

- 50 15. A method according to Claim 14 wherein the voltage signal is induced in the one or more conductors by means of an induction coil.

- 55 16. A press tool for use with the apparatus of Claims 1 to 11, the tool including at least one face adapted to engage a connector such that one or more contact elements are inserted therein, the face being provided with a plurality of electrically conductive portions separated one from another by regions of electrically insulating material.

- 60 17. A press tool according to Claim 16 wherein each conductive portion is provided with terminal means adapted to effect an electrical connection between the conductive portion and voltage monitoring apparatus.

- 65 18. A press tool according to Claim 17

wherein there is provided a socket attached thereto, terminals of the socket being in electrical connection with respective conductive portions.

- 70 19. A press tool according to Claim 18 wherein the socket is in the form of a pluggable telephone connector socket.

20. A press tool according to any of Claims 16 to 19 wherein the tool is of laminar construction with a plurality of conductive portions separated one from another by layers of electrically insulating material.

21. A press tool substantially as hereinbefore described with reference to the accompanying drawings.

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